Electromagnetic Engineering (EC 21006)
T U T O R I A L - X

TRANSMISSION LINES -- TIME DOMAIN ANALYSIS

1. In the transmission line of Figure 1, $R_L = Z_0 = 50\Omega$, and $R_g = 25\Omega$. Determine and plot the voltage at the load resistor and the current in the battery as functions of time by constructing appropriate voltage and current reflection diagrams.

Figure 1

2. In the transmission line of Figure 1, $Z_0 = 50\Omega$, and $R_L = R_g = 25\Omega$. The switch is closed at $t = 0$ and *is opened again* at time $t = l/4v$, thus creating a rectangular voltage *pulse* in the line. Construct an appropriate voltage reflection diagram for this case and use it to make a plot of the voltage at the load resistor as a function of time for $0 < t < 8l/v$ (note that the effect of opening the switch is to initiate a second voltage wave, whose value is such that it leaves a net current of zero in its wake).
3. In the charged line of Figure 2, the characteristic impedance is $Z_0 = 100\Omega$, and $R_g = 300\Omega$. The line is charged to initial voltage, $V_0 = 160\ V$, and the switch is closed at $t = 0$. Determine and plot the voltage and current through the resistor for time $0 < t < 8l/v$ (four round-trips).

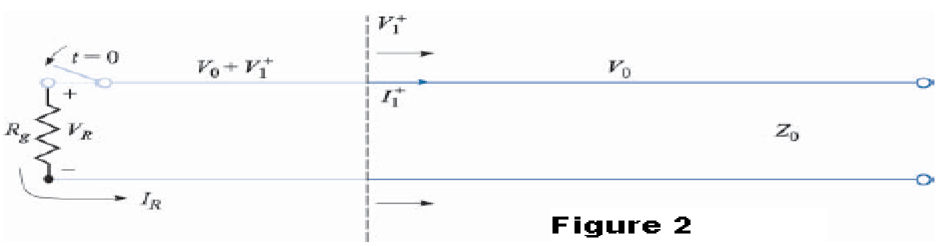

Figure 2

4. In the transmission line of Figure 3, the switch is located *midway* down the line and is closed at $t = 0$. Construct a voltage reflection diagram for this case, where $R_L = Z_0$. Plot the load resistor voltage as a function of time.

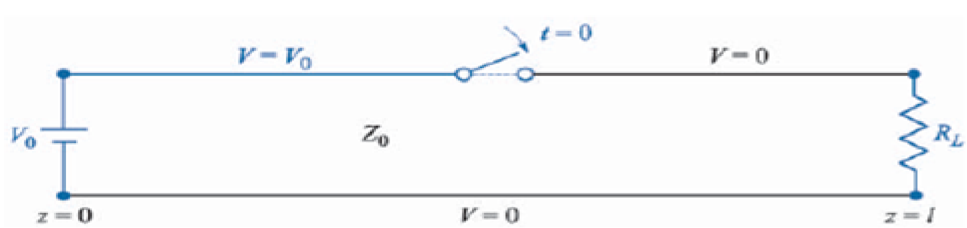

Figure 3

5. A simple *frozen wave generator* is shown in Figure 4. Both switches are closed simultaneously at $t = 0$. Construct an appropriate voltage reflection diagram for the case in which $R_L = Z_0$. Determine and plot the load resistor voltage as a function of time.

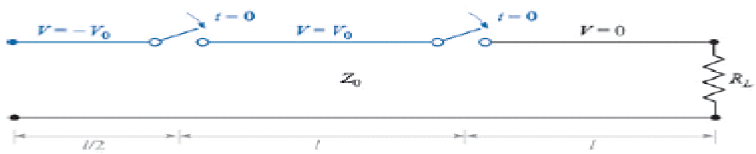

Figure 4

6. A 50-Ω transmission line having a transit time of 50 ns connects a pulse generator to a 150-Ω load resistance. The internal resistance of the pulse generator is 10 Ω, and its voltage magnitude is 10 V at no load. Determine the variation of the voltage at the midpoint of the line for duration of $5t_t$ if the pulse width is 1 ns.
7. A 2950-m-long, lossless telephone line is subjected to a $24\,u(t)\,V$ source having an internal resistance of 100 Ω, as shown in Figure 5. The per-unit-length inductance and capacitance of the line are 1.15 $\mu H/m$ and 10 pF/m, respectively. Sketch the voltage and current waveforms as a function of time at the midpoint when the transmission line is terminated into a load resistance of 500 Ω.

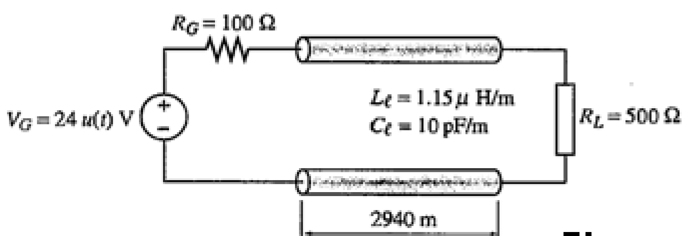

Figure 5

8. An 800-m-long, overhead transmission line having a transit time of 4 μs is connected to a 400-m-long cable with a transit time of 2 μs at point A, as shown in Figure 6. The characteristic resistances of the overhead line and cable are 200 Ω and 50 Ω, respectively. The receiving end of the cable is open-circuited, and the internal resistance of the source is assumed to be zero. Determine the variation of the voltage for duration of 30 μs at the receiving end of the cable when the overhead line is subjected to a unit step voltage.

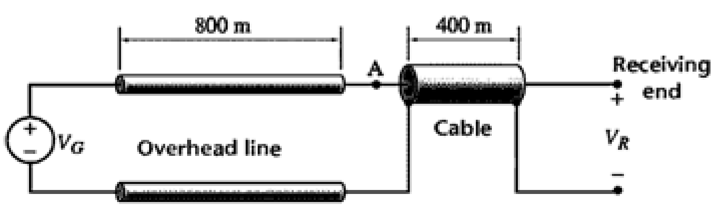

Figure 6